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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/853,925	05/09/2001	Tak Kin Chu	82528	7226

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James B. Bechtel
Office of Counsel (Patents) Code CD222
Naval Surface Warfare Center
Dahlgren Division
Dahlgren, VA 22448-5100

EXAMINER
PHAM, THANHHA S

ART UNIT	PAPER NUMBER
2813	

DATE MAILED: 10/04/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application N .	Applicant(s)	
	09/853,925	CHU ET AL.	
	Examiner	Art Unit	
	Thanhha Pham	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *20 September 2002* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *15-21 and 29-36* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *15-21 and 29-36* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

ETAILED ACTION

Specification

1. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

The following title is suggested: "A PROCESS FOR MAKING ELECTRONIC DEVICES WITH A MONOLAYER DIFFUSION BARRIER".

Claim Objections

2. Claims 18 and 20 are objected to because of the following informalities:

With respect to claim 18,

line 6, "375 C" should be changed to "375 °C"

With respect to claim 20,

lines 5 and 7, "375 C" should be changed to "375 °C"

Appropriate correction is required.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claims 17, 20-21, 29, and 34-36 are rejected under 35 U.S.C. 102(b) as being anticipated by Wada et al [US 5,661,345].

Wada et al, figs 11A-11E and related text col 1-26, discloses the claimed method making a semiconductor device having a single crystal metal wiring comprising steps of:

forming, on a surface of a substrate material (semiconductor substrate 11, fig 11B), a barrier film (22); and

forming a single crystal transition metal (23, Cu, Al, Ag, or Pt, fig 11E, col 11 lines 18-67, col 24 lines 52-55, col 26 lines 27-50) on the barrier film (22) wherein forming the single crystal transition metal (23) on the barrier layer (22) comprises the substeps of depositing a transition metal (23) on the barrier film (22) at the temperature below which the metal forms with a single crystal structure (see col 11 lines 28-36 which cites that forming a Cu thin film without annealing), and then annealing the resulting metallized substrate at a temperature effective to cause the transition metal to assume a monocrystal (single) structure (see col 11 lines 38-44 which cites that annealing the copper at the temperature of 550°C).

4. Claims 16, 18-19, 29 and 34-36 are rejected under 35 U.S.C. 102(b) as being anticipated by Hasunuma et al [US 5,498,909].

Hasunuma et al, fig 1 and col 1-35 more particularly embodiment 11 of text col 47, discloses the claimed process of making a semiconductor device comprising steps of:

forming, on a surface of a substrate material (<111> Si substrate), a barrier film (<111> single crystal Al); and

forming a single crystal transition metal (<111> Cu single crystal) on the barrier wherein forming the single crystal transition metal on the barrier layer (22) comprises depositing a transition metal on the barrier film concurrent with heating the substrate and the barrier film surface to a temperature of 375°C or higher (400°C) effective to cause the transition metal to assume a monocrystalline structure.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 16, 18-19 and 32-33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wada et al as applied to claim 29 in further view of Hasunuma et al [US 5,498,909].

With respect to claims 16 and 18-19, Wada et al. does not specifically teach or suggest a method of forming the single crystal transition metal on the barrier film comprises depositing a transition metal on the barrier film concurrent with heating the substrate and barrier film surface to a temperature effective to cause the transition metal to assume a monocrystalline structure. Nevertheless, forming a transition metal on the barrier film concurrent with heating the substrate and barrier film surface to a temperature effective to cause the transition metal to assume a monocrystalline structure is known in the semiconductor processing art as evidenced by Hasunuma et

al. Hasunuma et al teaches that a single crystal transition metal (e.g. Cu) can be formed by depositing the transition metal layer concurrent with heating the substrate and barrier film surface to a temperature of about 400oC. It would have been obvious to a person of ordinary skill in the art at the time the invention was made to form a transition metal on the barrier film concurrent with heating the substrate and barrier film surface to a temperature effective to cause the transition metal to assume a monocrystalline structure in the process of Wada as taught by Hasunuma et al. because forming a single crystal transition metal layer would provide a good electromigration resistance and reduce stress induced failure for forming a better device.

With respect to claims 32 and 33, it would have been obvious for those skilled in the art to select the thickness of the barrier as being claimed as a suitable barrier thickness in the process of Wada et al in making a semiconductor device with a smaller size as a demand of present semiconductor industry.

6. Claims 17, 20, 29-34 and 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hung [US 5,387,459] in view of Wada et al [US 5,661,345].

Hung, fig 1 and related text col 1-13 particularly col 4-6, discloses a process of making a semiconductor device comprising steps of:

homoepitaxial growing, on a surface of substrate (13, fig 1), a barrier (15, BaF2);

forming a transition metal layer (17, fig 1) on the barrier layer.

Hung et the transition metal layer (17) as a electrode wiring in a semiconductor device. Hung does not expressly teach the transition metal layer being a single crystal transition metal layer.

Wada et al teaches forming the electrode wiring with the single crystal transition metal layer in the semiconductor device would improve electromigration and stressmigration resistance to the eletrode wiring (see col 26 for details).

It would have been obvious for those skilled in the art to combine the teaching of Wada et al to the process of Hung to form the transition metal layer of single crystal as being claimed to improve electromigration and stressmigration resistance of the device.

With respect to claims 32 and 33, it would have been obvious for those skilled in the art to select the thickness of the barrier as being claimed as a suitable barrier thickness in the process of Wada et al in making a semiconductor device with a smaller size as a demand of present semiconductor industry.

7. Claims 16-21, 29, 32-36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hong et al [US 6,077,774] in view of Hasunuma et al [US 5,498,909] or Wada et al [US 5,661,345].

Hong et al, figs 1's and text col 1-5, discloses a method of making a semiconductor device comprising steps of:

forming, on a surface of substrate, a barrier (22, less than or equal 100 angstroms, fig 1B);

forming a transition metal layer (28, Cu, fig 1C) on the barrier layer.

Hong et al does not expressly teach the transition metal layer being a single crystal transition metal layer.

Hasunuma et al and Wada et al teach that forming the transition metal layer (e.g. Cu) as the single crystal transition metal layer would provide a better semiconductor device by improving electromigration and stressmigration resistance of the transition metal layer.

It would have been obvious for those skilled in the art to apply the teaching of Hasunuma et al or Wada et al to form the single crystal transition metal material on the barrier layer in the process of Hong to form a better device with reasons given above.

With respect to claims 16-21 and 33, it would have been obvious for those skilled in the art to select the suitable temperatures for forming the single crystal transition metal material and the barrier thickness as being claimed in the process of Hong et al in view of Hasunuma et al or the process of Hong et al in view of Wada et al.

8. Claims 15, 30-33 are are rejected under 35 U.S.C. 103(a) as being obvious over Wada et al [US 5,661,345] or Hasunuma et al as applied to claim 29 above in further view of Stumborg et al [US 6,291,876] .

The applied reference Stumborg et al [US 6,291,876] has a common assignee with the instant application. Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art only under 35 U.S.C. 102(e). This rejection under 35 U.S.C. 103(a) might be overcome by: (1) a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this application and is thus not an invention "by another"; (2) a showing of a date of

invention for the claimed subject matter of the application which corresponds to subject matter disclosed but not claimed in the reference, prior to the effective U.S. filing date of the reference under 37 CFR 1.131; or (3) an oath or declaration under 37 CFR 1.130 stating that the application and reference are currently owned by the same party and that the inventor named in the application is the prior inventor under 35 U.S.C. 104, together with a terminal disclaimer in accordance with 37 CFR 1.321(c). For applications filed on or after November 29, 1999, this rejection might also be overcome by showing that the subject matter of the reference and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person. See MPEP § 706.02(l)(1) and § 706.02(l)(2).

Wada et al and Hasunuma et al substantially discloses the claimed method including forming a single crystal transition metal (e.g. Cu, single/uniform crystal) on the barrier except teaching forming the barrier layer comprising homoepitaxial of BaF2, BaCl2, SrF2, SrCl2, CsF or CsCl.

Stumborg et al teaches that the barrier comprising homoepitaxial of BaF2, BaCl2, SrF2, SrCl2, CsF or CsCl can provide an extremely thin barrier for the transition metal material.

It would have been obvious for those skilled in the art to combine the teaching of Stumborg et al to the process of Wada et al or the process of Hasunuma et al to form the barrier comprising homoepitaxial of BaF2, BaCl2, SrF2, SrCl2, CsF or CsCl as being claimed to provide effective extremely thin barrier layer in making a

semiconductor device with a smaller size as a demand of present semiconductor industry.

With respect to claims 15, 32-33, it would have been obvious for those skilled in the art to select suitable range of temperature, pressure and thickness for forming the barrier layer in the process of Hasunuma et al in view of Stumborg et al or the process of Wada et al in view of Stumborg et al.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanhha Pham whose telephone number is (703) 308-6172. The examiner can normally be reached on Monday-Thursday 8:00 AM - 7:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Chaudhuri Olik can be reached on (703) 306-2794. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-3432 for regular communications and (703) 308-7725 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

Thanhha Pham
October 1, 2002

Tuan H. Nguyen

Tuan H. Nguyen
Primary Examiner